PHD GRANT

Graphene bioelectronics for long-term neuronal interfacing in-vivo

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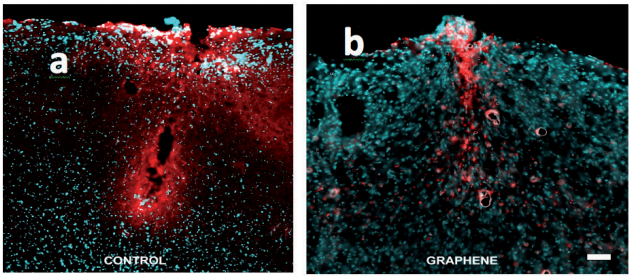
This PhD thesis aimed at testing new materials and coatings to improve in-vivo implants for brain bioelectronics interfaces. The high invasiveness of current implants is responsible for the formation of inflammatory reactions resulting from the concentration of reactive glial cells around the implant site, creating a physical barrier between the motor cortex neurons and the electrodes. This causes moto-neurons signals to disappear from recordings which become flooded by background noise. For that purpose, we have investigated how graphene coatings could be useful, as it allows combining a good bio-acceptance and a high-sensitivity electronics for the first time.



Cross sections of rat brain taken 3 months after implant surgery showing the inflamatory response (red : astrocytes) around the implant position. This response is reduced for graphene-covered implant (b) compared to state-of-the-art commercial implant (a).

Graphene offers an ideal platform for providing a stable bioelectronics interface. It is cytocompatible, chemically inert and flexible. We have tested graphene-coated surfaces and compared them to state-of-the art commercial implants, with tests both in vitro, by cultivating primary hippocampal neurons on the graphene monolayers, and in-vivo, by graphene implants (Fig 1). The graphene coated implants have been the best signal providers in term of spikes quality as well as regarding implant durability, a fact that is supported by the reduced inflammatory response at the implantation site. Accurate real-time samplings of motor cortex neurons signals at the single cell level are promising to re-establish proper locomotion control after spinal cord injuries.

OUTCOMES

[1] Sensing ion channels in neuronal networks with graphene transistors, arXiv :1705.00295 (2017), accepted for publication in 2D materials

[2] Biomimetic coating for minimizing the invasiveness of brain interfaces, compatible with graphene bioelectronics, submitted to Biomaterials.

Oral presentation: Graphene week Conference , Warsaw (Pl) 2016

Collaboration: EPFL